HARP

Hyper-Angular Rainbow Polarimeter

The Hyper-Angular Rainbow Polarimeter (HARP) mission is designed to measure the microphysical properties of cloud water and ice particles. HARP is a precursor for the new generation of imaging polarimeters to be used for detailed measurements of aerosol and cloud properties. The HARP payload, built by the University of Maryland, Baltimore County (UMBC), is a wide field of view (FOV) imager that splits three spatially identical images into three independent polarizers and detector arrays. This technique achieves simultaneous imagery of three polarization states and is the key innovation to achieve high polarimetric accuracy with no moving parts. The spacecraft consists of a 3U CubeSat with three-axis stabilization, designed to keep the imager pointing nadir during data acquisition. The hyper-angular capability is achieved by rapidly acquiring overlapping images.

The HARP mission is a joint effort between UMBC (the principal investigator institution), the Space Dynamics Laboratory (SDL), and the Science and Technology Corporation (STC). UMBC provided the instrument, instrument calibration, and science analysis; SDL provided the spacecraft, flight system integration, and mission operations; and STC led the science algorithm development and science application funded by the National Oceanic and Atmospheric Administration. The program is part of the NASA Earth Science Technology Office's In-space Validation of Earth Science Technologies (InVEST) program.

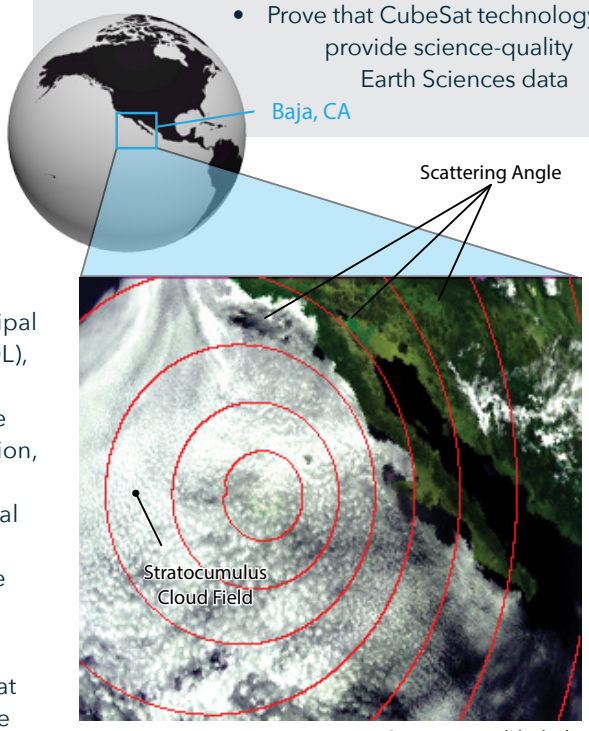
Cloud and aerosol processes influence climate change, which affects our oceans, weather, ecosystems, and society at large. The largest impediments to estimating climate change are a lack of quantitative information about aerosol forcing, insufficient understanding of aerosol-cloud processes, and cloud feedbacks in the climate system. New observations and a better understanding of aerosol-cloud processes will help to narrow climate change estimate uncertainties.

An imaging polarimeter with hyper-angular capability can make a strong contribution to characterizing cloud properties, especially ice clouds. Polarization and an increased number of observation angles provide a much clearer picture of cloud droplet distribution, adding size and width measurements to the currently measured effective radius.

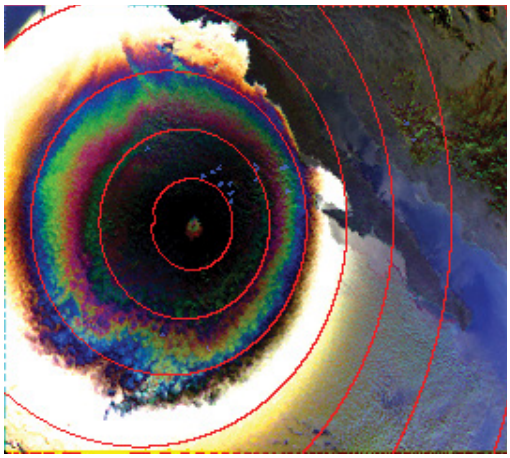
The combination of hyper-angular polarized measurements and short-wave infrared data will enable scientists to determine key characteristics of cloud ice crystals. Highly capable, small, and versatile, HARP is a novel, low-cost solution to studying clouds and aerosols in the atmosphere.

MISSION OBJECTIVES

- Validate new technology in space required for NASA's Decadal Survey Aerosol/Clouds/Ecosystems (ACE) mission
- Prove the on-flight capabilities of a highly accurate, wide FOV hyper-angle imaging polarimeter for characterizing aerosol & cloud properties
- Prove that CubeSat technology can provide science-quality Earth Sciences data



Scene in visible light



Same scene in polarized light
(Credit: National Centre for Space Studies)

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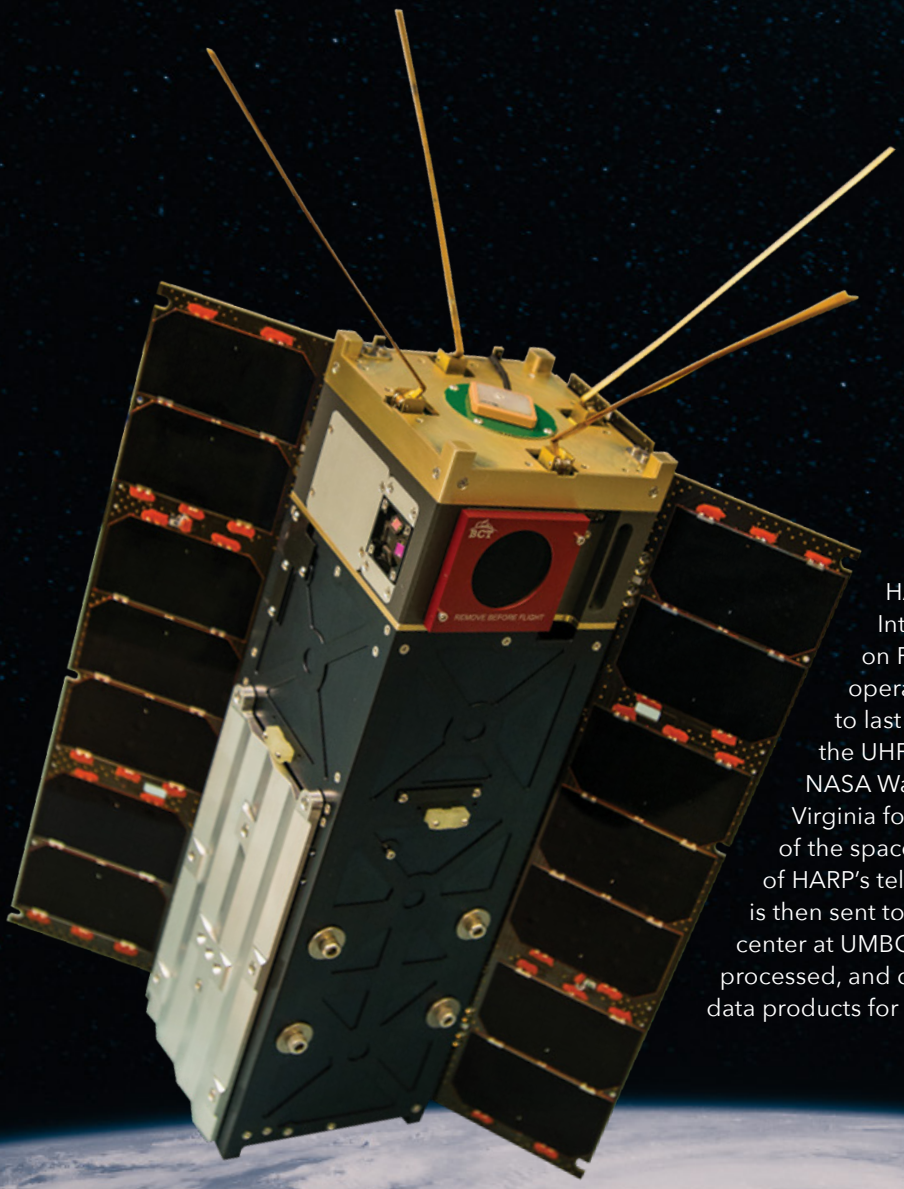
HARP Hyper-Angular Rainbow Polarimeter



HARP deployed from the International Space Station on February 19, 2020. Its operational mission is expected to last 6 to 12 months. SDL uses the UHF ground station at the NASA Wallops Flight Facility in Virginia for command and control of the spacecraft as well as collection of HARP's telemetry. Level zero data is then sent to the science operation center at UMBC, where it is calibrated, processed, and converted to final science data products for study.

UMBC

UMBC EARTH AND SPACE INSTITUTE

Joint Center for Earth Systems Technology (JCET)

STC SCIENCE & TECHNOLOGY CORP

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